African Journal of Biotechnology Vol. 10(78), pp. 17948-17953, 7 December, 2011
Available online at http://www.academicjournals.org/AJB
DOI: 10.5897/AJB11.403
ISSN 1684–5315 © 2011 Academic Journals

Full Length Research Paper

Economic evaluation and Applications of the Policy Analysis Matrix of sole and intercropping of leguminous and cereals Case study: Shirvan city-Iran

Mahmoud Sabaouhi[1], Ahmad Ghanbari[1], Fatemeh Rastegaripour[2]*, Abolfazl Tavassoli[2] and Yaser esmaeilian[2]

[1]Department of Agriculture, Zabol University, zabol, Iran.
[2]Department of Agriculture, Zahedan Branch, Islamic Azad University, Zahedan, Iran.

Accepted 4 November, 2011

In this study, data collected from North Khorasan Jihad Agriculture and Almanac foreign trade statistics for 2008 to 2009 were used to assess economic and relative advantages of sole and intercropping of millet and bean in Shirvan city by using benefit indicators. By using benefit to costs index, internal rate of return, net present value and policy analysis matrix were calculated. The results show that intercropping was affordable than sole cropping. Sole cropping of these crops had no relative advantage, while mixed cropping had a relative advantage than sole cropping. Nominal protection coefficient index about sole cropping of bean and intercropping showed that indirect tax has been imposed on producers. The nominal protection coefficient of the input in all types of indirect subsidies for cultivation proved to be opened by the trade. Coefficient of effective support net about sole cropping of beans and intercropping was less than the unit and total input and product markets in these cropping systems were not supported. Finally, the social net profit in beans and millet sole cropping was negative; while intercropping was positive, indicating that intercropping has a social net profitability. Overall results show that sole cropping of millet and bean in current situations of Shirvan city has no relative advantage, but intercropping system can increase the economic benefits and relative advantage.

Key words: Policy analysis matrix (PAM), relative advantage, economic assessment, intercropping.

INTRODUCTION

Increasing population of the world and decrease in natural resources confirmed that lack of food production is one of the major problems of the world. Therefore, increasing crop yield in order to answer to this ever-increasing demand of foods resources is necessary. Intercropping is defined as simultaneous growing of two or more crop species in the same field during a growing season (Ofori and Stern, 1987). The limited land areas are facing pressure to meet basic demands, especially for food, fiber and oil since most growers own very small plots of land, especially in the developing countries (Rezaei-Chianeh et al., 2011). Cereal-legume intercropping plays an important role in subsistence food production in both developed and developing countries, especially in situations of limited water resources (Tsubo et al., 2005).

Intercropping is popular because of its advantages over sole cropping which include security of returns and higher profitability due to higher total crop productivity, land equivalent ratio (LER) to varying degrees, low cost of production and ensuring economic utilization of labor and capital (Rao, 1991; Javanmard et al., 2009; Singh et al., 1996; Ofori and Stern, 1987). Although agricultural research had in the past persistently promoted mono-culture, however, this has been met with very little success among small holder farmers that are unable to address their diversified domestic needs to sustain normal livings from their limited land, water and economic resources

*Corresponding author. E-mail: Rastegaripour@yahoo.com.

Table 1. Framework of policy analysis matrix.

Calculated based:	Income	Exchange costs of input	Cost domestic input	Profit
According to private prices (market)	A_i	B_{ij}	C_{ik}	D_i
According to social prices (shadows)	E_i	F_{ij}	G_{ik}	H_i
Difference	I_i	J_{ij}	K_{ik}	L_i

and whose preference and problems have significantly underscored the importance of intercropping in their traditional farming systems (Edwards, 1993). The traditional farmers have reasons of technological, sociological, cultural and socio-economic for insisting on mixed farming. They proved that it is an insurance against crop failure, erosion control, efficient use of land, stability of yield, risk minimization, continuous and diversified food supply and higher yields (Steiner, 1982; Uvah, 1992). Listeria and Merpong (1980) studied the effect of different combinations of intercropping on high land areas and reported an increase in income in intercropping of three crops with a one row of each arrangement. In addition, Ghosh (2004) stated that intercropping offers to farmers the opportunity to engage nature's principle of diversity at their farms. Intercropping is a possible way of increasing the productivity on small farms, as it provides security against potential losses of monoculture. The yield losses of sole crop due to environmental condition may be compensated by intercrop (Fukai and Ternbath, 1993).

In this study, we assessed the capability of Shirvan city in pure culture and mixed millet and beans during 2008 to 2009 because of their economical assessment and relative advantage utilized as a standard for deciding determination on all kinds of pure culture. The pure values of the present indicators, rate of fund restoration, internal resources cost, effective protection coefficient, nominal protection coefficient from cultivation and product and sole net profit was used. General goals of this study included studying economical assessment and determination of the relative advantage of sole and intercropping of millet and bean in Shirvan city during 2008 to 2009, and analysis of sensibility of rating exchange action and product culture cost on relative indicators advantage.

MATERIALS AND METHODS

For accomplishing the study of financial and economical explanation of a plan and also comparison of different plans of investment that can be performed in an area, there are special methods that have widespread usage and others have narrow usage. In this investigation, we used three indicators: benefit-cost ratio (B/C), internal rate of return (IRR) and net present value (NPV). Internal rate of return is defined as follows;

$$\sum \frac{B_i - C_i}{(1+r)^i} = 0 \qquad (1)$$

In this equation, R is the internal rate of investment reset to zero, the total present costs and incomes, and demonstrate the maximum rate of profit that can be invested with it. If the internal rate of return becomes more than rate of bank return, then the plan has economical explanation. However, if it became less, then the plan does not have any economical explanation. Net present value is a standard that calculates the present value plans according to interest rate. If nominal protection coefficient (NPC) becomes positive it shows justification of plan. This relation is defined as follows (Oskoonejad, 2002):

$$\sum \frac{B_i - C_i}{(1+r)^i} \qquad (2)$$

Benefit-cost ratio is a standard that calculates the ratio of present value of benefits to total present value of cost in a significant interest rate. If this ratio becomes more then the unit, the plan has economical explanation, but if become less than 1 it does not have any economical explanation. The benefit-cost ratio is defined as follows (Oskoonejad, 2002):

$$\frac{B}{C} = \frac{\sum B_i / (1+r)^i}{\sum C_i / (1+r)^i} \qquad (3)$$

Policy analysis matrix was considered so as to achieve the goal of the study. The methods of policy analysis matrix also enable the researcher to practice the policy analysis alongside the calculation of the values of assessment and offer suitable policy recommenddation. The frame of policy analysis matrix is shown in Table 1 (Karbasi et al., 2005, Mahdipoor et al., 2006). As shown in Table 1, the first row include income matrix (Ai), cost related to interchangeable production (Bi) and un-interchangeable (Ci) and get benefit (Di) to production of one unit of product and assessed based markets values. The second row is the same item matrix from first row with this discrepancy that their calculation are accomplished based on society values of products, internal and external product and the third row of matrix is gotten from discrepancy between first and second rows and utilized in policy analysis. Also, the calculations of relative advantage indicators are presented in Table 2.

The shadowy value of opened by trade and closed by trade was calculated. Indicator that opened by trade included chemical fertilizer (phosphate, potassium and urea), herbicide and pesticide, seed, some parts of machinery costs and some are parts of conveyance costs. For chemical fertilizers, seed, herbicide and pesticide (imported from different countries) their cost, insurance and freight (CIF) values were based on shadowy values (Haji Rahimi, 1997, Malekdar, 2005, Gonzales et al., 1993). Shadowy machinery values assume parallel to average service costs for one hectare. According to studies carried out in other countries, it is assumed as 64% external machinery costs and 36% of it is internal (Haji Rahimi, 1997, Najafi and Mirzaei, 2003). It can be assumed that the leisure crops land costs is equal to shadowy costs and so determination of shadowy land costs should be respectively the average of the rent of land for rival products in an area. Shadowy

Table 2. Introduction of relative advantage indexes

Description	Definition	index
DRC<1: Production has a relative advantage Production has not a relative advantage: DRC>1: DRC=1: Head to head point	$DRC=\frac{G}{E-F}$	DRC
NPC<1: Indirect subsidies will received to producers : Indirect taxes imposed on producers NPC>1 NPC=1: the product not supported	$NPC = \frac{A}{E}$	NPC
NIPC<1: indirect subsidies paid for traditional inputs NIPC>1: Producer paid indirect tax because of use these inputs NIPC=1: does not any Support policy about this inputs	$NIPC = \frac{B}{F}$	NIPC
EPC<1: Government intervention about this production was detritus EPC>1: government policy supports the production process EPC=1: does not any Support policy about this inputs by government	$EPC=\frac{A-B}{E-F}$	EPC
NSP>0: There is relative advantage for production NSP<0: There is not relative advantage for production NSP=0: Head to head point	$NSP=(E-F-G)$	NSP

conveyance costs frame is derived from total market costs and difference of subsidies fuel costs (Malekdar, 2005). Shadowy cost (economical value) of water was calculated utilizing the simple liner program (Tahamipour et al., 2006, Keramatzadeh et al., 2006). Shadowy rate of foreign exchange has special importance in the calculation of relative advantage and in the determination of the rate of government support. Indeed, this rate is based on acceptable shadowy value for products and traditional inputs. In this study, parity of purchase power theory in relative and absolute situation for calculating the shadowy rate of exchange was used. By using the relative parity of purchase power (PPP relative) method, the shadowy rate at 2008 was calculated as (Mohammadi, 2004):

$$PER = Er \times (WPI / CPI)$$

In this relation, Er is free rate of exchange, WPI is the whole sale indicators value abroad and CPI is the internal indicators value of consumer based on year 2004. Market rates of exchange were gotten from statistics obtained from Central Bank's web site. Also, by using the absolute parity of purchase power method, the rate of shadowy exchange was calculated as follows (Mohammadi, 2004):

$$E = P_{ig} \div P_{dg}$$

Where, P_{ig} and P_{dg} are one ounce gold in internal market (according to Rial) and global market (dollar), respectively. The essential information and statistics were gotten from the calculation of the world grocery organization. Statistics and essential information were also obtained from North Khorasan Jihad Agriculture (2008) and also parts of the published information were obtained from Almanac foreign trade statistics customs and board of Jihad Agriculture.

Agriculture has an important role in the development of Shirvan city and most villagers of this region subsist by this agriculture. With regards to limited recourses for agricultural practices, it seems that economic application of these resources is necessary. Due to the importance of agriculture in the economy of Iran and especially in Shirvan city, economic assessments and investigation of the relative advantages of all kinds of cropping systems in this area is therefore very important.

RESULTS AND DISCUSSION

In this study, financial processes including costs and revenues were reviewed from sole and intercropping of millet and bean project in the Shirvan city, Iran. Costs included land, equipment, machinery, office equipment and others. Project income included income from product sales a year. For a clearer shadow price of production and raw materials, possible indicators of comparative advantage comes from providing sole and intercropping of millet and bean production. With the usage of incomes and costs, the final results from the economic assessment were obtained. Table 3 shows the result of economic assessment.

According to the results of economical assessment, we observed benefit-cost ratio in sole and intercropping of millet and bean respectively as 1/6, 1/5 and 1/9. Therefore, since these ratios were more than one, it showed that during the period, utilization for each mixed culture related to pure culture had a great deal of income for farmers. Internal rate of return respectively in sole and intercropping of millet and bean was 51, 34 and 68%, which was more than banks' rate of profit for this investment. Hence, while design costs and income become equal during the exploitation, benefit rate of return respectively in sole and intercropping of millet and bean

Table 3. Results of economic assessment.

Product	IRR (%)	B/C
Pure millet cultivation	39	1.5
Net bean cultivation	51	1.6
Mixed cultures	68	1.9

Table 4. Results of sensitivity analysis of B/C ratio change rate.

Mixed culture	Net bean cultivation	Pure millet cultivation	Interest rates (%)
1.9	1.65	1.58	10
1.86	1.59	1.51	12
1.75	1.48	1.45	14
1.69	1.41	1.39	16
1.63	1.36	1.36	18
1.58	1.32	1.29	20

was 51, 39 and 68%. According to income numerics, costs and rate of profit was altered with time, and to better distinguish the changes effect of this element on profit and design economic, explanation showed that if income are respectively more than 13, 10 and 38%, then there is decreased mixed culture for beans and millet. The results of sensitivity analysis protect costs related to rate of different profit are shown in Table 4.

After specifying the shadowy product cost and cultivation, the possibility of determination of relative indicators advantage was provided. The results of relative indicators advantage are showed in Table 5. This table shows the results of policy analysis matrix based on absolute and relative PPP mode. According to the results for beans and mixed cultures, Ii <0, which meant that the market price was less than the shadow price of the product. An implicit tax on domestic producers has been imposed. But for Jij, matrix in the three cases was less than zero, the domestic producers of inputs were imported from the higher world prices to buy it. Moreover, Kik matrix that represents the difference between the costs of domestic inputs required producing a single product to market and shadow price was greater than zero. Li is income difference matrix calculated based on market and shadow prices; shows the effect of government intervention in the profits of production is considered here in a state of relative PPP. Li <0 obtained in beans and mixed cultures, profit shadow gained market and profit producer with the acts of government policy intervention can be affected.

Furthermore, DRC in mixed cultures case was less than one. This meant that there was comparative advantage in mixed cultures cases. The nominal protection coefficient (NPC) is a ratio that contrasts the observed (private) commodity price with a comparable world (social) price. This ratio indicates the impact of policy (and of any market failures not corrected by efficient policy) that causes a divergence between the two prices. The NPC on tradable outputs (NPCO), defined as A/E, indicates the degree of output transfer; NPC in the form of PAM in beans and mixed cultures was less than unit, while on other hand the market price was less than the product shadow prices. An NPC on inputs of 0.45 showed that policies are reducing input costs; the average market prices for these inputs were only 45% of the world prices. Nominal protection coefficient of input (NIPC) indicating how the support of external inputs (interchangeable) uses the appropriate relationship in the context of PAM in all cases was less than one, and this meant that the cost of inputs can be traded at market prices less than its shadow price cost.

In addition, the effective protection coefficient (EPC), another indicator of incentives, is the ratio of value added in private prices (A - B) to value added in world prices (E - F), or EPC = (A - B)/(E - F). This coefficient measures the degree of policy transfer from product market-output and tradable-input-policies. EPC was less than one for beans and mixed cultures in this project. Finally, net social profitability (NSP), which profits from production with the application of shadow prices and product production and internal and external inputs were calculated according to formulas and value in the PAM framework in mixed cultures was positive. Furthermore, following sensitivity analysis, sole and intercropping of millet and bean are presented in Table 6. Studying the effects of change in rate of exchange on the relative indicator advantage, the rate changed to 9000, 10000, 11000, 12000, 13000 and 14000 Rials. NIPC index value based on PPP was reduced relative to the improved exchange rate means, thereby increasing the shadow price of inputs, while its shadow price was stable. Also, increased exchange rate index was less than NPC because exchange rate and imports were more expensive, while the price of product in the domestic market remains

Table 5. Products comparative advantage indices calculated in two cases of relative and absolute PPP.

index	Millet		Beans		Mixed culture	
	PPP Absolute	PPP Relative	PPP Absolute	PPP Relative	PPP Absolute	PPP Relative
I_i	289874.67	137380.09	-633845.25	-805718.55	-633845.25	-805718.55
J_{ij}	-199894.93	-257497.35	-78929.08	-139541.79	-119298.24	-169578.54
K_{ik}	69810.70	44152.04	62791.29	34748.70	79009.29	56806.27
Li	419958.90	350725.39	-617707.46	-700925.46	-593556.30	-692946.27
D_i	174692.18	174692.18	-786216.02	-786216.02	-585583.42	-585583.42
H_i	-245266.72	-176033.21	-168508.56	-85290.56	7972.88	107362.85
DRC	1.39	1.24	1.23	1.10	0.96	0.89
NPC	1.28	1.12	0.45	0.40	0.45	0.40
NIPC	0.49	0.43	0.81	0.71	0.65	0.57
EPC	1.77	1.54	0.26	0.22	0.37	0.32
NSP	-245266.72	-176033.21	-168508.56	-85290.56	7972.88	107362.85

Table 6. Effect of exchange rate changes on the comparative advantage index.

Culture type	Comparative advantage index	900	1000	1100	1200	1300	1400
Net Millet	DRC	1.35	1.22	1.15	1.08	1.02	0.96
	NPC	1.24	1.09	1.01	0.93	0.86	0.8
	NIPC	0.48	0.42	0.39	0.36	0.33	0.31
	EPC	1.71	1.5	1.4	1.28	1.18	1.1
	NSP	-229505	-162665	-122561	-69088.6	-15616.4	37855.8
Net Beans	DRC	1.19	1.08	1.02	0.96	0.9	0.86
	NPC	0.44	0.39	0.36	0.33	0.3	0.28
	NIPC	0.78	0.69	0.64	0.59	0.54	0.51
	EPC	0.25	0.22	0.2	0.19	0.17	0.16
	NSP	-149706	-71119.2	-20875.4	43539.85	107955.1	172370.3
Mixed culture	DRC	0.96	0.87	0.82	0.77	0.72	0.68
	NPC	0.44	0.39	0.36	0.33	0.3	0.28
	NIPC	0.63	0.56	0.52	0.48	0.44	0.41
	EPC	0.36	0.32	0.29	0.27	0.25	0.23
	NSP	30439.83	124285.9	184285.9	261208.9	338131.9	415054.9

Reference: Research findings.

constant. Increasing the rate of exchange also caused the NIPC indicator to become smaller

Conclusion

The interpretation of PAM results generally followed a set pattern; the analyst first explains private profitability, then discusses social profitability and finally turns to the causes of the difference between private and social profits. This task requires the identification of divergences. The logic is straightforward. Private valuations differ from social valuations because something gets in the way to make the observed market valuation (the private price) diverge from the efficient valuation or social opportunity cost (the social price). According to calculations based on a policy analysis matrix, results show that the mixed cultures in Shirvan city is of social benefit. This meant that after the national areas of comparative advantage such as production, employment and value added in the mixed cultures was of economic justification.

REFERENCES

Edwards RJA (1993). Traditional farming systems and farming systems research. In: Dry Land Farming in Africa. Rowland, J.R.J. (Ed.). Macmillan Education Ltd., pp. 95-108.

Fukai S, Ternbath BR (1993). Processes determining intercrop productivity and yield of component crops. Field crops Res. 34: 247-271.

Ghosh PK (2004). Growth and yield competition and economics of Groundnut/ cereal fodder intercropping system in the semi-arid tropics Of India. Field Crop Res. 88(2-3): 227-237.

Gonzales LA, Kasrino F, Peres ND, Rosegrant MW (1993). Economic Incentives and Comparative Advantage in Indonesian Food Crop Production. Report NO.93, International Food Policy Research Institute, Washington D.C.

Haji Rahimi M (1997). Economic incentives and comparative advantage of crop production in Fars province. MSc thesis, Shiraz University, Shiraz, Iran.

Javanmard A, Dabbagh Mohammadi-Nasab A, Javanshir A, Moghaddam M, Janmohammadi H (2009). Forage yield and quality in intercropping of maize with different legumes as double-cropped. J. Food, Agric. Environ. 7(1): 163-166.

Karbasi A, Karimkoshte MH, Hashemi Tabar M (2005). Review comparative advantage in producing cotton blue in Golestan province. J. Agric. Econ. Dev. 50: 29-53.

Karbasi A, Shamsaldini S, Rastegaripour F (2009). Major agricultural products to determine comparative advantage in Kerman province. J. Agric. Econ. Dev. 65:1-15.

Keramatzadeh A, Cheizari AH, Mirzaee A (2006). Determine the economic value of agricultural water use model integrated farm model optimized planting and Gardening: A Case Study Barzv Dam Shirvan. J. Agric. Econ. Dev. 54:35-60.

Mahdipour A, Sadr Alashrafi M, Kazem Nejad M (2006). Review comparative advantage in production of potatoes. J. Agric. Sci.1:15-25.

Malekdar M (2005). Economic production Soybean in Mazandaran province. MSc thesis, Zabol University.

Mohamadi D (2004). Determine comparative advantage in oilseeds production and review problems in Fars province. J. Agric. Econ. Dev. 47: 125-170.

Najafi B, Mirzaei A (2003). Review and determine the comparative advantage crops in Fars province. J. Comm. 26:35-50.

Ofori F, Stern WR (1987). Cereal-legume intercropping systems. Adv. Agron. 41: 41-90.

Oskonejad M (2002). Engineering economics or economic assessment of industrial projects. Amir Kabir University Publishing Center.

Rao VP (1991). A study on intercropping of cotton with grain legumes under rainfed conditions. J. Res, Andra Pradesh Agric. Univ. 19(20): 73-74.

Rezaei-Chianeh E, Dabbagh Mohammadi Nassab A, Shakiba MR, Ghassemi-Golezani K, Aharizad S, Shekari F (2011). Intercropping of maize (*Zea mays* L.) and faba bean (*Vicia faba* L.) at different plant population densities. Afr. J. Agric. Res. 6(7): 1786-1793.

Singh G, Singh OP, Kumar M, Rajput AL, Murya S (1996). Effect of intercrops on yield and economics, weeds and pest infestation of deep water rice. Allals Agric. Res. 17(1): 14-17.

Steiner KG (1982). Intercropping In Tropical Smallholder Agriculture With Special Reference To West Africa. Germany, German Agency for Tech. Coop (GTZ).

Tahamipour M, Karbasi M, Daneshvar Kakhki A (2006). Determine the function of water in agriculture Tqasay, Pistachio Karan Zarand city case study. Agric. Sci. Ind. 1: 103-116.

Tsubo M, Walker S, Ogindo HO (2005). A simulation model of cereal-legume intercropping systems for semi-arid regions. Department of Soil, Crop and Climate Sciences, University of the Free State. Field Crops Res. 93: 1.

Uvah II (1992). Crop diversity and Management. Nig. J. Entomol. 5:5-11.